



COMPARISON OF COMMUNITY RESPONSE TO ROAD TRAFFIC NOISE IN JAPAN AND SWEDEN—PART I: OUTLINE OF SURVEYS AND DOSE–RESPONSE RELATIONSHIPS

T. SATO

Department of Architecture, Hokkai Gakuen University, 064-0926 Sapporo, Japan.

E-mail: sato@arc.hokkai-s-u.ac.jp

T. YANO

Department of Architecture and Civil Engineering, Kumamoto University, 860-8555 Kumamoto, Japan

AND

M. BJÖRKMAN AND R. RYLANDER

Department of Environmental Medicine, University of Gothenburg, 413-90 Gothenburg, Sweden

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To investigate cross-cultural differences in the community response to road traffic noise, social surveys were conducted in Gothenburg, Sweden, and Kumamoto and Sapporo, Japan, using the same questionnaire and noise measurement method. Typical residential areas with detached houses and apartments were selected as the target areas in each city. The questionnaire comprised 40 questions relating to environmental, housing and personal factors. The key questions concerned annoyance caused by road traffic noise. The total numbers of respondents were 1142 in Gothenburg, 837 in Kumamoto and 780 in Sapporo. The response rates were 68.8, 69.3 and 57.5% respectively. After the questionnaires were completed, noise measurements were made in each area. Community responses were compared on the basis of the dose–response relationships. There were no systematic differences between community responses in Sapporo and Kumamoto, which have the same culture. People living in detached houses in Gothenburg were more annoyed by the same road traffic noise than the people living in Japanese cities. There were no systematic differences among the three cities with regard to activity disturbances indoors, but significant disturbance of activities and resting in gardens or on balconies was noted in Gothenburg. The difference in activity disturbance was due to the differences between lifestyles in the two countries. People living in detached houses were more annoyed by the house vibration caused by road traffic than those living in apartments and people were annoyed by the exhaust from road traffic to the same extent as noise.

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1. INTRODUCTION

Social surveys on road traffic noise have been conducted all over the world. The importance of the effects of non-acoustical factors on annoyance in a uniform cultural background has been pointed out in some reports. However, community responses to noise may have been affected by cultural and climatic differences in the areas surveyed. Of particular interest is

how to utilize the results of annoyance studies in many countries for the establishment of a general noise evaluation system. To shed light on this problem, Jonsson *et al.* [1] conducted a joint study in Sweden and Italy in 1969 using a unified method. They concluded that the differences in annoyance reactions seemed to be dependent on differences in living conditions, on different requirements and on different evaluations of motor traffic as a part of the physical environment. The present authors [2, 3] have also found differences in community responses in preliminary joint studies conducted in Japan, Sweden and Thailand. On the other hand, several studies on the annoyance responses to environmental noise among residents of different types of housing have also been conducted. Fields [4] reviewed 14 surveys and concluded that annoyance is not affected by the type of dwelling. However, there were discrepancies in the noise sources, housing types and results of these surveys. In a recent study, the authors [5] found differences in annoyance responses to road traffic noise among people living in detached houses, row houses and apartment houses. A series of social surveys was conducted to examine how and why the community responses to road traffic noise were different between residents of detached houses and apartments and between people living in Japan and in Sweden using the same questionnaire and noise measurement method. In the present report, differences in community responses to road traffic noise in Gothenburg, Sweden, and Kumamoto and Sapporo, Japan, are described.

2. OUTLINE OF THE SURVEY

Sapporo is located in the northern part of Japan, which has a comfortable summer temperature and cold winters, while Kumamoto, in the southern part of Japan, has a very hot and humid summer. Gothenburg is located in the western part of Sweden, which has almost the same temperature as Sapporo but is more humid in winter. The cultures of the two countries are very different.

Eleven to 15 typical residential areas with both detached houses and apartment houses were selected as the target areas in each city. All of the houses surveyed faced roads. The questionnaire consisted of 40 questions related to environmental, housing and personal factors. The key questions concerned annoyance caused by road traffic noise. The answers were given on a five-point category scale. The respondents, from 18 to 75 yr of age in Gothenburg and from 20 to 75 yr of age in Kumamoto and Sapporo, were randomly selected on a one-person-per-family basis.

TABLE 1
Outline of the survey

	Gothenburg	Kumamoto	Sapporo
Survey period	January–June, 1996	May–November, 1996	October 1997–October 1998
Number of respondents	Detached: 436 Apartment: 706	Detached: 378 Apartment: 459	Detached: 411 Apartment: 369
Response rate (%)	Detached: 73.3 Apartment: 66.4	Detached: 76.1 Apartment: 64.6	Detached: 63.5 Apartment: 52.0
Noise exposure level $L_{Aeq(24)}$ (dBA)	Detached: 46.2–73.6 Apartment: 48.5–82.3	Detached: 49.3–73.7 Apartment: 51.3–73.5	Detached: 53.3–73.6 Apartment: 52.1–70.7

Rating scale for key questions: 1. not noticed; 2. not annoyed; 3. a little annoyed; 4. rather annoyed; 5. very annoyed.

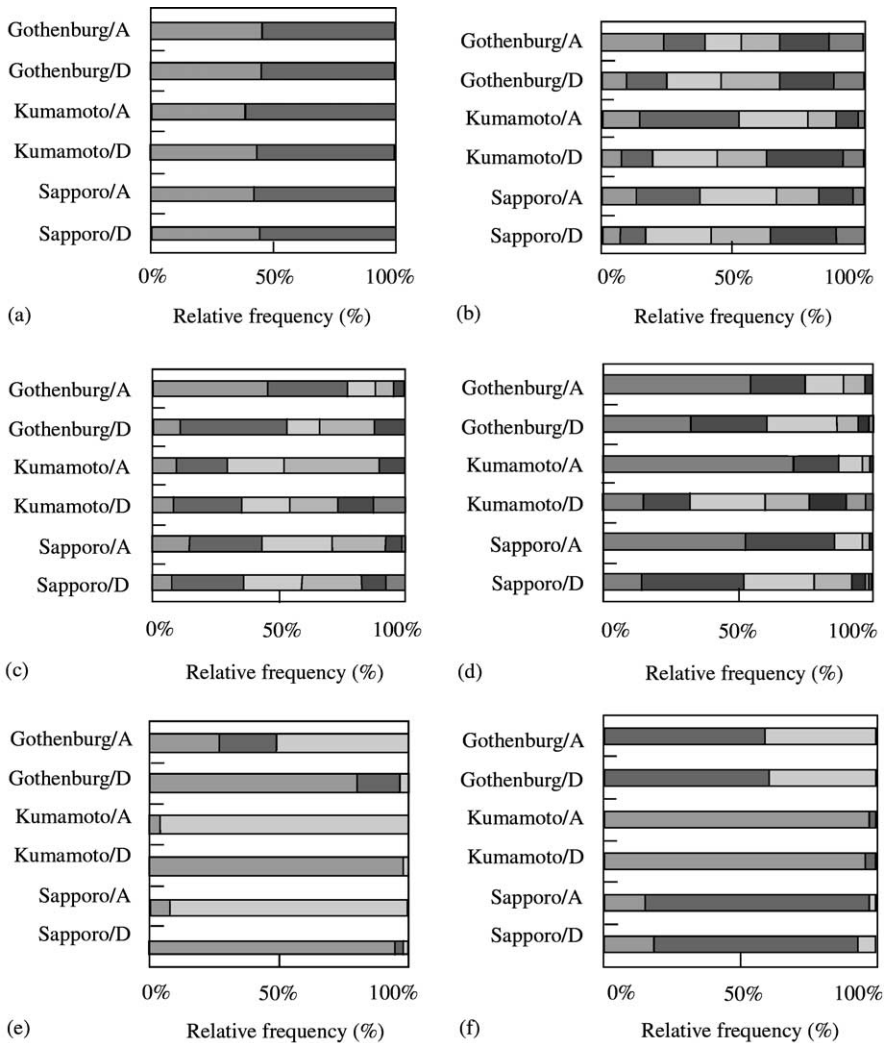


Figure 1. Relative frequencies of responses to questions concerning personal and housing factors: A: Apartment house, D: Detached house. (a) Gender: □, male; ■, female (b) Age: □, <30; ■, 30-40; □, 40-50; □, 50-60; ■, 60-70; ■, 70+ (c) Number of family members: □, 1; ■, 2; □, 3; □, 4; ■, 5; ■, 6-. (d) Length of residence: □, <10; ■, 10-20; □, 20-30; □, 30-40; ■, 40-50; ■, 50-60; ■, 60-. (e) House structure: □, wood; ■, brick; □, RC. (f) Window type: □, 1 pane; ■, 2 panes; □, 3 panes or more.

The total numbers of respondents were 1142 in Gothenburg, 837 in Kumamoto and 780 in Sapporo, and the response rates were 68.8, 69.3 and 57.5% respectively.

After the questionnaires were completed, two types of physical measurements were made in each area. One was a 24-h continuous noise measurement at a reference point close to the roadside. The other was a noise reduction measurement at 5, 10, 20 and 40-m points on the ground level from the reference point and at each floor level of apartment houses. The noise exposure for each house was determined using these data. Differences in average sound pressure levels inside and outside of external walls with windows were measured in the three cities using the method recommended by the Architectural Institute of Japan. The numbers and kinds of vehicles passing in front of the reference point were manually counted during the 24-h measurement period. The study design is summarized in Table 1.

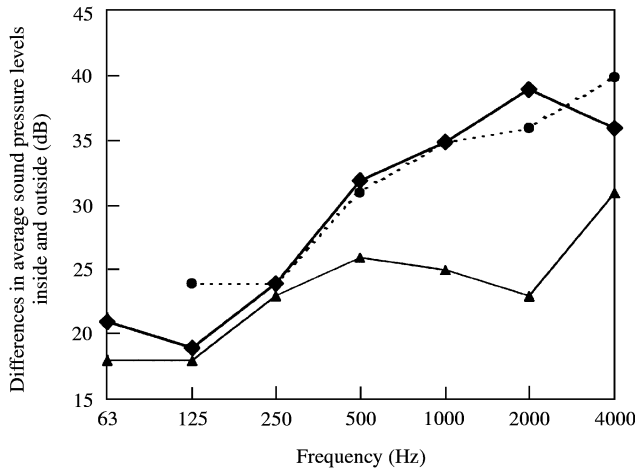


Figure 2. Comparison of sound insulation of external wall with window: —◆—, Gothenburg; ---●---, Sapporo; —▲—, Kumamoto.

3. RESULTS

Figure 1 shows the relative frequencies of responses to questions concerning personal and housing factors. There was a wide distribution of responses regarding personal factors in each city. Although the structures of detached and apartment houses were different, the windows of the two housing types were similar in each city, indicating that the degrees of sound insulation in the two housing types in each area are almost the same. The degree of sound insulation was found to be high in Gothenburg and Sapporo but much lower in Kumamoto, as shown in Figure 2.

Community responses were compared on the basis of dose-response relationships, as shown in Figure 3, in relation to the extent of very annoyed within each noise exposure level, according to cities and housing types. It is seen that people living in detached houses reported annoyance more often than those living in apartment houses in Gothenburg, while no significant difference in the extent of the annoyance response was found between people living in different housing types in Kumamoto and Sapporo. There were no significant differences between Sapporo and Kumamoto, which have the same culture. On the other hand, there were no systematic differences between countries in disturbances to indoor activities, such as disturbance to listening to the TV or radio and disturbance to sleep. There were significant disturbances to activities and resting in gardens or on balconies in Gothenburg.

Table 2 reports the results of chi-square test for the differences of responses between cities and between housing types. It is seen that significant differences were found in general noise annoyance between detached and apartment houses in Gothenburg for almost all noise levels. No significant differences were found for interference with TV/radio listening and awakening, whereas significant differences were found for rest/relaxation outdoors between Japanese cities and Gothenburg.

4. COMMENTS

The postal method was used in Gothenburg, while the distribute-collect method was used in Kumamoto and Sapporo. In our previous study [3], there were no significant differences in community responses obtained by these two methods.

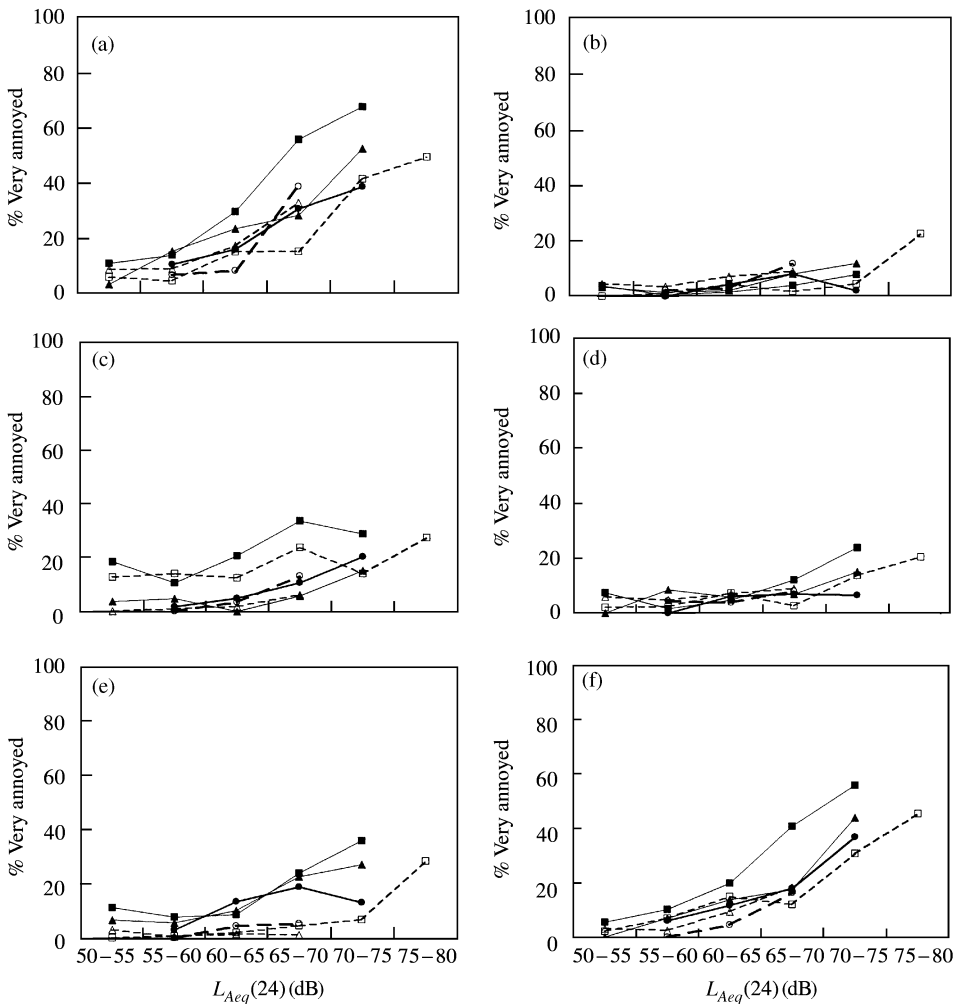


Figure 3. Comparison of community responses to acoustical and non-acoustical factors. “%very annoyed” refers to the proportion of people who responded “very annoyed”: (a) Road traffic noise annoyance; (b) TV/radio listening disturbance; (c) rest/relaxation disturbance in garden/balcony; (d) awakening; (e) house vibration; (f) exhaust fumes. —▲—, Kumamoto/Detached; —■—, Gothenburg/Detached; —●—, Sapporo/Detached; --△--, Kumamoto/Apartment; --□--, Gothenburg/Apartment; —○—; Sapporo/Apartment.

Considering the differences in sound insulation of houses in the three cities, it seems that sound insulation does not have a significant effect on annoyance responses. This difference is probably related to differences in customs between the two countries, such as spending time outdoors in gardens or on balconies in Gothenburg. With regard to non-acoustical factors, it was found that people living in detached houses were more annoyed by house vibration caused by road traffic than people living in apartment houses. This difference may be explained by a difference in house structures. It was also found that people were annoyed by exhaust from road traffic to the same degree as they were annoyed by noise. Exhaust fumes are one of the most serious sources of annoyance in the living environment.

There were no systematic differences between community responses in Sapporo and Kumamoto, which have the same culture. People living in detached houses in Gothenburg

TABLE 2
Chi-square test

L_{Aeq} (dB)	KD×GD	KA×GA	KD×KA	GD×GA	SD×SA	SD×KD	SD×GD	SA×KA	SA×GA
(a) Road traffic noise annoyance									
50-55	—	—	—	—	—	—	—	—	—
55-60	—	—	—	**	—	—	—	—	—
60-65	—	—	—	**	—	—	*	*	—
65-70	**	**	—	**	—	—	**	—	**
70-75	—	—	—	*	—	—	*	—	—
(b) TV/radio listening disturbance									
50-55	—	—	—	—	—	—	—	—	—
55-60	—	—	—	—	—	—	—	—	—
60-65	—	—	—	—	—	—	—	—	—
65-70	—	—	—	—	—	—	—	—	**
70-75	—	—	—	—	—	—	—	—	—
(c) Rest/relaxation disturbance in garden/balcony									
50-55	—	*	—	—	—	—	—	—	—
55-60	—	**	—	—	—	—	—	—	*
60-65	**	**	—	—	—	*	**	—	*
65-70	**	**	—	—	—	—	**	—	*
70-75	—	—	—	—	—	—	—	—	—
(d) Awakening									
50-55	—	—	—	—	—	—	—	—	—
55-60	*	—	—	—	—	*	—	—	—
60-65	—	—	—	—	—	—	—	—	—
65-70	—	—	—	*	—	—	—	—	—
70-75	—	—	—	—	—	—	—	—	—
(e) House vibration									
50-55	—	—	—	*	—	—	—	—	—
55-60	—	—	*	**	—	—	—	—	—
60-65	—	—	**	**	*	—	—	—	—
65-70	—	—	**	**	**	—	—	—	—
70-75	—	—	—	**	—	—	*	—	—
(f) Exhaust fumes									
50-55	—	—	—	—	—	—	—	—	—
55-60	—	*	—	—	—	—	—	—	—
60-65	**	—	—	—	*	—	**	—	**
65-70	**	—	—	—	**	—	**	—	—
70-75	—	—	—	*	—	—	—	—	—

Note: KD, Kumamoto/detached; KA, Kumamoto/apartment; GD, Gothenburg/detached; GA, Gothenburg/apartment; SD, Sapporo/detached; SA, Sapporo/apartment; **, significant above 1% level; *, significant above 5% level; —, not significant.

were more annoyed by the same road traffic noise than people living in Japanese cities. There were no systematic differences among the three cities with regard to activity disturbances indoors, but a significant disturbance to activities and resting in gardens or on balconies was found in Gothenburg. People living in detached houses were more annoyed by house vibration caused by road traffic than were those living in apartments and people were annoyed by exhaust from road traffic to the same extent as noise.

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